

USDA Hurricane Mitch Recovery Program

Special Objective 1—

Damaged Rural Watersheds Rehabilitated through Strengthened Local Capacity.

SECTION II: DETAILED ACTIVITIES BY COUNTRY

A. Country Program Description—Honduras

Program Objectives and Summary

Most of the destruction wrought when Hurricane Mitch struck Honduras in October 1998 was water-related. The long and intense rains caused massive flooding, soil erosion, landslides, and sediment deposition resulting in extensive damage to agricultural lands, roads, stream banks, and towns. Accordingly, USDA identified the rehabilitation of damaged watersheds as a focal point of its reconstruction effort since it is the quality of watershed management which affects the ability of the land to regulate water runoff, conserve scarce soil and forest resources, protect rural infrastructure, and provide for the myriad of products and environmental services required by an agricultural economy.

Results Framework

Special Objective 1 (SpO 1), *Damaged Rural Watersheds Rehabilitated through Strengthened Local Capacity*, was addressed through a combination of four intermediate results in Honduras:

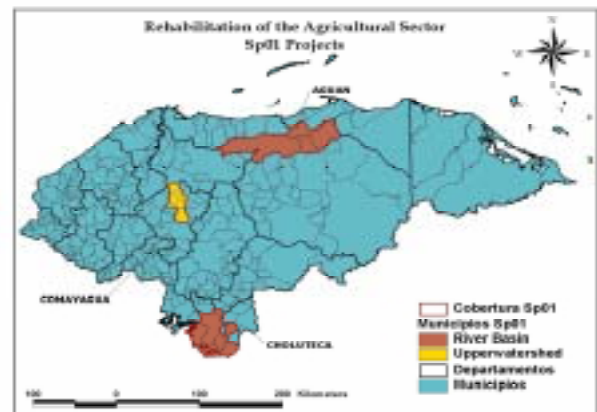
- Emergency Watershed Protection Implemented for Critical Sites (IR1.1)
- Land and Water Resources Rehabilitated in Priority Watersheds (IR 1.2)
- Local Capacity to Mitigate Future Storm Effects Strengthened (IR 1.3)
- Rural Housing Rehabilitated (Upper Watershed only) (IR 1.4)

To accomplish this work, USDA successfully employed a participatory project planning and implementation process in which technical specialists from the USDA Forest Service, Natural Resources Conservation Service, and land grant universities (accessed through the USDA Cooperative State Research, Education, and Extension Service) partnered with local communities and NGOs in the selected hurricane-affected watersheds. Joining together, USDA and its' local partners defined specific rehabilitation needs and then addressed those needs through on-site technical guidance, grants, and materials and supplies

The Hurricane Mitch Recovery Program (HMRP) was divided into two primary sub-programs: one addressed storm damage and other vulnerabilities in the upper watershed areas of the Humuya River; the other targeted the lower watersheds of the Aguan River, and Choluteca River (figure 1).

Michael Donald, USDA Forest Service, served as the resident leader of the upper watershed program, coordinating USDA's grant-supported NGO partners, a Cornell University-led consortium, and USDA technical specialists on short-term assignment. Dr. Kenneth Schlather, USDA Cooperative State Research, Education and Extension Service/Cornell University, led the lower watershed rehabilitation activities, coordinating USDA technical specialists on short-term assignment, and overseeing local field staff.

Figure 1. Map showing locations of the Aguan and Choluteca watersheds (Lower Watershed activities) and the Humuya watershed above Comayagua (Upper Watershed activities).



USDA addressed multiple vulnerabilities in both the upper and lower watershed programs. In the upper watershed, efforts focused on stabilizing rural roads, hillside lands, and stream banks to withstand the negative effects of future storms. Reforestation activities and the installation of improved wood burning stoves were aimed at decreasing tree cover degradation on hillsides and other lands. By increasing tree cover, sloping lands are less vulnerable to erosive rains. In addition, lands with plant cover have greater water infiltration rates so more water percolates into the ground rather than running over it.

Stream bank stabilization activities made key spots along rivers less likely to breach during rising flood waters, thus reducing the potential of damaging flooding of agricultural lands and communities. At a housing site for people displaced by the hurricane, drainage work was conducted to protect the land from soil erosion. A variety of other activities were undertaken to reduce the vulnerability of rivers and streams to pollution from human waste, coffee pulp, and sediment. Also, many hillside areas were made less vulnerable to soil erosion and landslides through the installation of live barriers, and planting of trees and other vegetation to stabilize soil and proved plant cover.

The planned impact of these activities was to achieve on-the-ground, physical rehabilitation/repair/protection at various locations as well as strengthening the technical capacity of NGO partners, local communities, and others.

Key Accomplishments/New Technologies--Upper Watershed Program

In the early part (August 1999) of the Hurricane Mitch Program, USAID Honduras stated its interest in having USDA concentrate rehabilitation efforts in the upper watershed of the Humuya River. USDA conducted a field assessment of the watershed confirming wide-scale damage and documenting specific problems (e.g., soil erosion and sediment production in locations deemed to be critical sites.) that could effectively be addressed by the application of USDA technical resources

Within the Humuya watershed, four micro-watersheds (*microcuencas* in Spanish) were identified to be the focal areas of USDA's work. Each micro-watershed contains (and takes its name from) a small river feeding into the Humuya River. Four towns have boundaries that fall within one or two of the micro-watershed areas. The towns, with their respective micro-watersheds are listed below:

<u>Municipality</u>	<u>Microwatershed</u>	<u>Size of microwatershed (hectares)</u>
La Libertad	Rio Encanto	2011
	Rio Frio	1200
	Rio Salitroso	1664
Las Lajas	Rio Colorado	3744
Ojos de Agua Libertad)	Rio Encanto	2011 (also listed above under La
	Rio Achiote	944
San Jeronimo	Quebrada de los Muertos	1247
	Quebrada de las Dantas	1100

Key Accomplishments/New Technologies under IR 1.1

Emergency Watershed protection implemented for critical sites

Through installation of improved drainage structures, and correction of soil erosion and water runoff problems, 163 road exigencies were eliminated, and 43.8 kilometers of rural farm-to-market roads in were rehabilitated. Specific road exigencies included sites of poor road drainage resulting in serious soil erosion, washouts, undercutting of land supporting bridges, landslides, and serious sedimentation of waterways. These exigencies were both sites of damage and causes of damage as well, as they continued to serve as major producers of sediment and excessive water runoff ultimately affecting other locations. Local communities and USDA technical specialists agreed that these particular areas posed threats to life and/or property and were critical for action. HMRP activities included the installation of 59 culverts (figure 2), as well as numerous dips, fords, and other interventions, undertaken with full community involvement.



Figure 2. Culvert being placed to improve road drainage and prevent damaging water runoff

Success of this work is owed to several groups: a cadre of USDA engineers and foresters who formed a “core road team” to carry out multiple short-term assignments; an innovative partnership with Fondo Cafetero Nacional in which they provided heavy machinery and some of their staff, while USDA provided culverts and technical guidance; and local communities whose active participation was encouraged and facilitated through assistance from a consortium led by Cornell University (see IR 1.3 accomplishments for more detail).

One hundred houses were protected from excessive water runoff and flooding, and soil erosion and sediment production were reduced, at Colonia La Pista, an emergency community built north of La Libertad for victims of Hurricane Mitch. In 1999, GOAL, an Irish NGO, constructed a 100-house community on a former airstrip in the hills of the Humuya watershed. The community was raised on land without proper surface drainage, resulting in soil erosion at the site and the production of sediment which flowed into the river. Also, because of the lack of a drainage system, many homes were being flooded during storms. To correct the situation, USDA provided technical review of the problem, advice on how to fix it, and a grant of \$22,105 to support the installation of a comprehensive surface drainage system, which included 1800 meters of drainage

canal and full erosion protection to each drainage outfall. Without this corrective action by USDA, the housing development would have been at risk from future storm effects, and the site would have continued to be a source of sediment in the watershed. Along with the drainage installation, USDA reforested the areas within and around the Colonia to reduce surface runoff into the housing site. A total of 2900 trees were planted, including 700 for reforestation near streams, 1,800 for reforestation in surrounding areas, and 200 fruit trees and 200 ornamental trees in the community.

Key Accomplishments/New Technologies under IR 1.2
Land and water resources rehabilitated.

Seventy-eight hectares of water sources were protected by fencing in selected areas of the Humuya micro-watersheds; the work resulted in greater protection of communities' potable water from sediment and contamination. Local communities in the Humuya rated as highest priority the protection of the micro-watersheds that produce their potable water. Erecting fences around water sources (figure 3) provides a barrier to farm expansion into the areas of forest buffer that help keep water sources free of sediment and microbial and agrichemical contamination in runoff from farms.



Figure 3. Fenced water source

621 hectares of critical areas in targeted micro-watersheds were reforested with 217,175 trees helping to stabilize slopes, establish trees on degraded lands, and reduce vulnerability to future storms. USDA promoted reforestation by providing several vital services: targeted grants to NGO partners, technical guidance, and coordination of tree planting. Grants to Fundación Banhcafe and Proyecto Aldea Global (PAG) for nurseries and reforestation totaled \$63,204. Fundación Banhcafe established 40 small nurseries, while PAG established 4 large nurseries of 12,500 seedlings each (figure 4).



Figure 4: Tree nursery established by Proyecto Aldea Global through a grant from USDA

Trees were planted by streams, on hillsides, and on farms in order to provide woody vegetation to stabilize land, reduce erosion, and protect streams. Both forest and fruit tree species were used. USDA and its partners believe that fruit trees will provide a long-term incentive to maintain forest cover because they eventually provide income as well as a subsistence food source to the local landowner. The community would be less likely to cut down fruit trees than other species of trees, thus insuring that there would be long-term maintenance of forest cover. Although these nurseries were established for the purpose of providing reforestation stock for the USDA project, it is expected that several will continue to produce seedlings for locally initiated planting projects in the future.

A total of 8 km of streams were rehabilitated by stabilizing damaged stream banks through the use of bio-engineering techniques and planting of vegetation. Unstable stream banks cause new damage in other locations because they serve as sources of sediment into the stream and may allow stream water to flood into agricultural areas, eroding farmland. Bio-engineering is the innovative use of primarily natural materials such as logs, boulders, and soil, to rebuild, strengthen, and stabilize damaged banks. Often, after vegetation grows back over the newly fortified banks, it is not readily apparent that any repair was ever done. The following diagram and photo illustrate the use of bio-engineering technology.

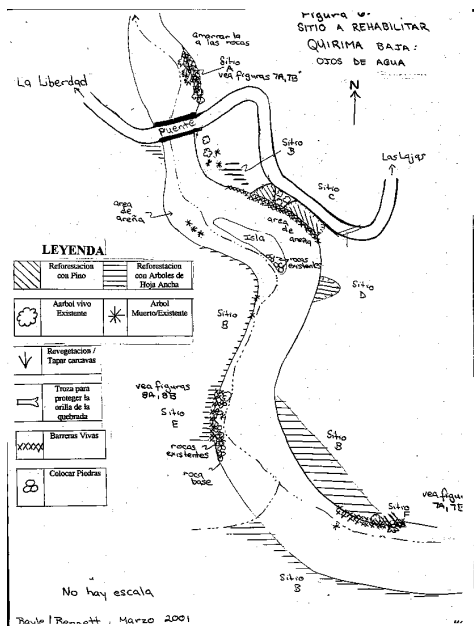


Figure 5. Diagram of plans for stream bank repair

Figure 6. Photo of bio-engineering work on one of the stream banks in diagram

Six sites, comprising 10.5 hectares of landslides, were stabilized through vegetative plantings.

Landslides caused the major sedimentation problems to streams during Hurricane Mitch. This sediment filled the natural streambeds so that the water holding capacity of the stream was reduced, greatly increasing flooding effects on downstream communities.



Without stabilization, landslides would have continued depositing sediment into the streams, especially during storm events. USDA implemented vegetative planting of the landslide sites utilizing volunteers from the Honduras Conservation Corps (Cuerpos de Conservacion Honduras), a conservation NGO comprised of youth from around Honduras.

Figures 7-8. Hillside stabilization



Planting of 56,283 linear meters of live erosion control barriers reduced soil erosion by holding soil in place in agricultural land on slopes.

These barriers, planted with pineapple and other crop types, are expected to require minimum maintenance. USDA provided \$10,500 (part of a \$99,259 grant to promote sustainable agricultural practices among families in four Mitch-damaged municipalities in the Humuya) to PAG in support

of barriers construction. Live barriers not only hold the farmers' soil on the land, but sometimes also serve as a useful crop themselves.

Sources of microbial contamination to water in the Humuya from human waste were reduced by the construction of 524 latrines. Hurricane Mitch focused people's attention on the quality of water resources and the need to make improvements in their watershed. The USDA participatory diagnostics in the communities of the Humuya, revealed the communities' strong interest in addressing the problem of water contamination. Results from water quality testing supported by USDA showed high fecal coliform counts in the water. The lack of latrine facilities in the areas has long been suspected as a contributor to this problem. To help protect potable water in the Humuya, USDA provided a grant of \$40,000 to the NGO, Caritas. The grant funded the construction and placement of the latrines.

Many sources of sediment in the critical areas of the Humuya upper watershed were removed through the elimination of road exigencies. Poorly drained roads are a major source of sediment, as can be witnessed by anyone traveling on such roads during a storm. Previously discussed under IR1.1, the elimination of 163 road exigencies is cited here also because of its value in removing significant sources of sediment and ultimately aiding the rehabilitation of the damaged water resources.

Through the use of new coffee de-pulping technology, significant reductions in water pollution from coffee processing were achieved (estimated reduction of 646,800 liters of polluted water from three sub-watersheds). Coffee is the main agricultural crop in the upper Humuya watershed, and processing of the coffee fruit after harvest to remove the pulp is a source of water pollution in the area. In the "wet processing" method, the coffee pulp is discarded directly into the stream. Pollution results from the dumping of large amounts of organic material into the water; pesticides on the pulp itself add to the pollution. USDA provided an innovative "dry processing" machine to COCALAL, a progressive coffee cooperative in Las Lajas in the upper Humuya. The dry processing machine uses minimum amounts of water, and the coffee pulp waste it ejects may be composted and decomposed with red worms and then used as a fertilizer.



Figure 9. “dry processing” machine

The use of the dry processing machine in last year’s harvest prevented pollution of an estimated 646,800 liters of water. Coffee (with shade trees) is a very suitable crop for the upper Humuya watershed, and desirable for watershed protection since it provides much more vegetative cover to the ground than other crops. In addition to introducing the “dry processing alternative”, USDA also provided COCOLAL technical assistance in seeking “eco-friendly” or “organic” certification for their coffee. The hope is that if higher returns are gained for dry processed coffee, other Humuya farmers will want to use this process as well.

Key Accomplishments/New Technologies under IR 1.3

Local capacity strengthened to mitigate future storm effects

Participatory diagnostics, related trainings, and community organizing led by Cornell University supports rehabilitation efforts in the Humuya, and increases local capacity to protect water sources, rehabilitate roads, and manage their micro-watersheds. Participatory diagnostics were a tool to help the target communities 1) identify and map problems in their micro-watersheds, 2) prioritize the identified problems, 3) develop an action plan, and 4) take action utilizing technical assistance from USDA and its grantees in the Humuya. Cornell University resident staff were integral to the Hurricane Mitch program, providing the fabric of a network that included NGO grantees, local communities, municipalities, Peace Corps Volunteers, Crisis Corps Volunteers, and USDA specialists on short-term assignments. Cornell undertook the community participation project work with the support of a \$564K grant from USDA. Purdue University also provided assistance to this component.



Figure 10 . Training in doing participatory watershed mapping

Working in close consultation with the USDA Upper Watershed Rehabilitation Advisor, Cornell facilitated the community organizing and planning tasks needed to launch and implement the rehabilitation projects. Cornell led the community participation component of the dry processing technology introduction with the Las Lajas-based coffee cooperative, COLOLAL, providing the dry processing coffee machine, and working with the community to produce fertilizer by composting the coffee waste.



Figure 11. Participants conferring at workshop to identify problems in their watershed

List of selected outputs from Cornell-led activities that were critical to the USDA success

- Participatory watershed maps for 7 micro-watersheds, and action plans to address the problems.
- Identification of locations where reforestation and other activities were needed.
- Development and implementation of a community-based watershed management training series for municipal environmental units.
- Organizing numerous trainings in participatory watershed mapping, water monitoring and analysis, and rural road rehabilitation and maintenance.
- Facilitation of 4 inter-municipal forums on municipal development with an emphasis on watershed management; workshops involved over 50 local leaders.

- Farm action plans with 25 progressive coffee farmers in the municipalities of Las Lajas, La Libertad, San Jeronimo, and Ojos de Agua. Action plans addressed needs in soil conservation, use of green manures, crop diversification, integrated pest management, and integrated nutrient management. One tangible outcome of the action plans was production of over 3,000 50-pound bags of fermented organic fertilizer from coffee waste.
- Training sessions in various topics of integrated pest management and integrated nutrient management; workshops involved a combined total of 305 participants.
- Completion of action plans with 25 farmers to address soil and water conservation problems in riparian area, resulting in the distribution of 6000 iris plants and 2000 plants of vetiver grass to make 2000 meters of live barriers.
- Farmer training (45 farmers) in improved crop management practices and use of alternative crops.

Planting of 80,178 linear meters of live-fencing reduced the need to cut wood for fence-posts, helping to maintain tree cover in the watershed. The use of live fences should reduce the need for future fence post replacement (in live fencing, young tree limbs stuck in the ground take root and grow as small trees which serve as living fence posts). Depending on the species used, the branches sprouting from these live fence posts can be used as fodder, or ground into green manure. Live fencing requires little maintenance. USDA provided a grant of \$4,245 to Fundacion Banhcafe to promote and establish live fences.

Installation of 1,131 improved, fuel-efficient stoves, reduced the need for deforestation for fuel-wood, and increased the opportunity to retain protective tree cover in the watershed. The major source of cooking fuel within the Humuya upper watershed is firewood. Reducing the demand for firewood means that fewer trees need to be cut for to provide cooking fuel, allowing these trees to remain as a protective forest cover in the watershed.



Figure 12. New improved stove with owner

The stoves, locally manufactured, reportedly use only half as much wood as the stoves they replaced, and have the added benefit of a chimney which draws the smoke out of the

house. The improved stove technology is already showing promise; an undetermined number of additional households have installed the fuel-efficient model after seeing its benefits, including a hotter cooking fire. USDA's support for this activity included a grant of \$50,884 to PAG and \$3,695 to Fundacion Banhcafe for stove manufacture and installation.

Training in water quality monitoring improved local capacity in this technical area; the field-based activities also revealed high fecal coliform counts in potable water systems, highlighting the need for improved watershed management to reduce contamination. The need for potable water was a key issue that brought people together on the broader issue of improving watershed management. Trainees included members of COCOLAL, local teachers, community members, Peace Corps and Crisis Corps Volunteers, local water system managers, and staff from Fundacion Banhcafe, who also provided some of the training.



Figures 13-14. USDA conducts field training in water testing.

USDA provided a grant to Fundacion Banhcafe for \$3,630 for water testing in the Humuya. USDA also provided water-testing equipment and intensive training in its use. In the second year of the project, 171 water samples were taken. This water quality monitoring has allowed communities to realize first-hand the negative effects of some current practices on the quality of their watershed. An additional years' supply of chemicals for the testing kits was provided so that communities can continue monitoring beyond the life of the project.

Through their partnership with USDA, Fondo Cafetero Nacional and local communities learn new and better ways to maintain roads to prevent erosion and landslides due to storms. Fondo Cafetero Nacional (FCN) is the Honduran agency with responsibility for maintaining secondary farm-to-market roads in coffee growing areas (including the Humuya watershed). USDA partnered with FCN to implement repair of some of the roads and to provide them with improved technical approaches on the sizing and placing of culverts.



Figure 15. Farm-to-market road repair in the Humuya upper watershed

Agreements were made with each of the four municipalities covering the Humuya upper watershed; USDA provided materials (such as culvert tubs) and technical expertise; FCN provided heavy machinery and staff; and the communities attended road maintenance training and formed maintenance committees. Through the partnership, USDA fostered a commitment from local communities to help maintain the rehabilitated roads in the future.



Figure 16. Community members using hand labor to practice simple but effective road drainage improvement techniques.

Road rehabilitation training, manuals for rural road design with minimum impacts, and best management practices for rural roads increased local capacity to build and maintain environmentally-sound farm-to-market roads. During road repair, USDA provided skill-building workshops and adapted and distributed the USDA Best Practices in Forest Roads training manual (*Manual de Prácticas Mejoradas en Caminos Forestales*). Trainees included community members, contractors, NGO staff, and engineers from Fondo Cafetero Nacional.

Training of farmers in organic farming, soil conservation, establishment of tree plantations and agroforestry, and training of artisans in improved stove construction resulted in on-the-ground project accomplishments, and improved local capacity for future work in the Humuya. Training grants and technical assistance to USDA's NGO collaborators were crucial to the successful completion of project activities.

Key Accomplishments/New Technologies under IR 1.4 ***Rural Housing Rehabilitated***

Construction of 202 kitchen/latrine annexes improved homes built for victims of Hurricane Mitch, and reduced household sources of stream water contamination. Hurricane Mitch destroyed or damaged many homes throughout the Humuya upper watershed. In late 1999, Proyecto Aldea Global (PAG) had already undertaken the task of constructing basic housing units for Hurricane Mitch victims in 3 communities of the Humuya upper watershed, but it had no funding for kitchen/latrine annexes. USDA agreed to support this construction through a grant of \$92,700 (to PAG). USDA technical specialists reviewed the annex construction work in the field and gave advice on making further improvements. In addition, USDA fitted the kitchens with fuel-efficient cook stoves. These kitchen/latrine annexes essentially made the homes more desirable, functional, and sanitary.



Figures 17-18. Left photo--Pressed earthen blocks roll off from one of 3 block machines for home construction in Humuya area; Right photo--Interior wall under construction with earthen blocks

Provision of three mobile earthen block machines greatly supported home building to replace destroyed, damaged, or vulnerable houses in the Humuya upper watershed. Three machines that press soil into adobe earthen blocks were donated by USDA to PAG to expand their Hurricane Mitch house reconstruction program. With an additional USDA grant of \$8,415, PAG provided locally trained operators to take the machines around to different communities for use in new home construction or existing home improvement. USDA also provided a diesel engine to PAG to rehabilitate an earthen block machine that had broken down.



Figure 19. PAG staff and community members learn improved adobe home construction techniques during a USDA training session.

Expert training and consultation in earthen adobe home construction applied new techniques to improve sturdiness of the homes, reducing vulnerabilities to severe storms and earthquakes. USDA provided the services of a US expert in earthen adobe block home construction who provided training and consultation in building safer dwellings. Improved techniques included the use of a mud slurry as a mortar to make the walls much stronger, use of a continuous bond beam around the top of the walls, and use

of cement-stabilized blocks at the bottom of the exterior walls to avoid block weakening from water penetration. PAG staff and community members working on the home construction projects were the beneficiaries of this training and technology transfer.



Figure 20. School/storm shelter at Brisas del Campo, Humuya Watershed.

Construction of school/storm shelter at Brisas del Campo improves the community. Brisas del Campo was one of the three communities where PAG constructed houses with USDA support for the addition of kitchen/latrine annexes. USDA provided \$22,709 in a grant to enable PAG to construct the school, under the provision that it function as a storm shelter as well. USDA also offered technical advice for improved construction methods.

Development and dissemination of a Spanish-English handbook on use of pressed earthen blocks for construction improves local technical capacity to produce good quality adobe houses. To institutionalize the improved construction practices transferred to PAG and the communities in the upper Humuya, USDA produced a handbook, *Pressed Earthen Block Construction Guidelines (Guia Para La Construcción con Bloque Tierra Prensado)*. Written specifically for this project by the USDA adobe construction expert who consulted on the project, the handbook provides instructions and diagrams for simple, sturdy, earth block home construction in Honduras. Approximately 300 copies of this 31-page, fit-in-your-pocket guide were supplied to PAG.

Improvements in drainage protected 100 houses constructed for hurricane victims from flooding and other water damage. Also mentioned under IR1.1, USDA provided a grant of \$22,105 and technical assistance to GOAL (Irish NGO) to improve drainage at the Colonia La Pista housing site. Protection of these houses benefited 550 residents.

Key Accomplishments/New Technologies in the Lower Watershed

Hurricane Mitch struck the Choluteca and Aguan Valleys particularly hard, devastating some of the most productive agricultural sectors and land in the country. The plantain crop sector was nearly 100% destroyed, more than 70% of sugar cane lands were flooded for more than a week, more than half of all melon lands were washed away, and 50% of the dairy industry was lost.

The lower watershed work was focused on rehabilitating damaged agricultural land and reactivating the agriculture on that land which had been disrupted by the hurricane (IRs 1.2 and 1.3).

Key Accomplishments/New Technologies under IR 1.2

Land and water resources rehabilitated

Lower watershed accomplishments under this IR have been organized by crop or crop type.

Technical assistance in dairy for 254 farmers in the Aguan and Choluteca watersheds, had a beneficial impact on 743 ha. of dairy agricultural land, and added \$714,000 in land value. The main losses to dairy farmers from Hurricane Mitch were in animals and infrastructure, including milking and feeding structures, fencing and irrigation systems. Many farms lost their access to water because the rivers and streams changed their courses. The damage exacerbated already existing problems of feed shortages, poor quality animals and pastures, and poor access to water for drinking.

Figure 21. Boring wells provides farmers with water



Technical assistance focused first on feed production and then on feed preservation so that farmers could assure themselves of sufficient feed during the dry season. USDA also assisted some farmers in regaining access to drinking water for their cows. Farmers have embraced the new methods and technologies promoted by USDA, including sowing of several new pasture grasses, silage and hay making, artificial insemination of cows using good quality bloodlines, and use of new livestock watering systems and diversion dams. Tables 1 and 2 on the following page show details of the improvements.

Table 1. Dairy-Choluteca

# of Producers in Project: 173 # of Groups in Project: 14 Total Area of their Farms: 1729 ha					
Type of Rehabilitation Work	Number of Producers	Area Affected/Quantities	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Land Leveling	83	74 ha	\$14,800	\$37,000	\$51,800
Pasture Replanting	173	324 ha	\$64,800	\$162,000	\$226,800
Irrigation	37	102 ha	\$3,600	\$102,000	\$105,600
Wells, Water Impoundments	26	5 wells, 2 water impoundments; 96 ha**	\$9,600	\$45,000	\$54,600
Silos/Silage	128	8 Silos, 515 tons silage	\$30,900	\$16,000	\$46,900
Hay	111	24,325 bales	\$36,500	NA	\$36,500
Artificial Insemination	64	150 cows inseminated	\$15,000	NA	\$15,000
Feeding Areas	21	3 feeding areas		\$6,000	\$6,000
Milking Parlors	16	5 milking parlors		\$7,500	\$7,500
Farm Mgt Plans/ Soil Sampling	51	18 plans (457 ha.)	Unknown	NA	
Totals	173*	369 ha + infra. and more			\$550,700

* Some producers received assistance in more than one type of intervention

** The 96 hectares are part of the 101 hectares included in the data on irrigation

Table 2. Dairy-Aguan

#r of Producers in Project: 102 # of Groups in Project: 9 Total Area of their Farms: 806 ha					
Type of Rehabilitation Work	Number of Producers	Area Affected/Quantities	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Land Leveling	3	7 ha	\$1,400	\$3,500	\$4,900
Pasture Replanting	62	85 ha	\$17,000	\$51,000	\$68,000
Water impoundment, irrigation, water syst.	26	301 ha (260 ha with water systems, rest w/ irrigation)	\$21,600	\$72,700	\$94,300
Silos, Silage, Hay	13	Not Yet Known*			
Total	81	293 ha	\$40,000	\$127,200	\$163,200

* Farmers were just beginning to produce silage and hay at the close of the project. We know of at least 13 producers who are producing silage.



Figure 22. Land leveling makes damaged sugar cane fields usable again

Land reparations to Mitch-damaged sugar cane fields in Choluteca raised land values by \$1000/hectare or more. Flooded rivers deposited sediments over much of the sugar cane land in the lower Choluteca watershed. More than half of the fields were covered in a layer of sandy sediment, sometimes to a depth of more than a meter. USDA's rehabilitation included leveling the land and mixing in the sediments. Mixing in the newly deposited sediments was particularly beneficial because it lightened the normally heavy clay soils, resulting in a post-Mitch sugar cane crop with a very good yield. In the case of the very first farm reclaimed, the yield after rehabilitation was better than any the farmer had obtained before. In addition, USDA provided for the boring of shallow wells for irrigation on some farms. The increase in land value for the 277 ha. directly treated on this project has totaled \$347,000.

Table 3. Sugar Cane-Choluteca

<i># of Cane Producers in Region: >400 # of Producers in Project: >350</i> <i>Area Damaged by Mitch: >4,000 ha Total Area of their Farms: >8,000 ha</i>					
Type of Rehabilitation Work	Number of Producers	Area Affected	Value of Intervention (Value of 1st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Land Leveling	6	74 ha	\$37,000	\$59,200	\$96,200
Irrigation/Wells/Reservoirs	22	175 ha	\$52,500	\$175,000	\$227,500
Replanting	3	18 ha	\$6,000	\$18,000	\$24,000
Soil Sampling/Fertility Planning/Trials	125	>900 ha	Unknown	NA	
Variety Trials	>350*	>5,000 ha	Unknown	Unknown	
Totals	131 (>350)*	277 ha + >5,000 ha	\$95,500	\$252,200	\$347,700+

* 131 farmers received direct assistance; the rest will be benefiting from the variety trials, which are being managed by the two sugar mills in the region.

Interventions of land leveling, irrigation, and technical advice to rehabilitate Choluteca's important melon growing lands directly helped 67 producers to recover. Choluteca is the home of Honduras' melon export industry. Hurricane Mitch severely damaged much of the melon growing land, which is primarily located by streams. USDA worked with the melon growers' association in Choluteca to identify farmers who had suffered serious damage. Assistance in land leveling and irrigation helped prepare damaged lands for planting again. Additional assistance included an assessment of a vine decline-like disease and implementation of variety trials to ascertain resistance levels among melon varieties. Some assistance was also delivered to farmers in the Aguan area, where damage was considerably less and melons are grown for only the domestic market.

Table 4. Melon and Watermelon-Choluteca

<i># of Small & Medium Melon/Watermelon Producers in Region: >100</i>					
<i># of Producers in Project: 67</i>		<i># of Groups in Project: 10</i>		<i>Area Damaged by Mitch: > 400ha (>300 lost)</i>	
Type of Rehabilitation Work	Number of Producers	Area Affected/Quantities	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Land Leveling	23	59 ha	\$59,000	\$59,000	\$118,000
Irrigation	41	41 ha	\$41,000	\$41,000	\$82,000
Pest Management	13	39 ha	Not Yet Known		
Soil Sampling, Fertility Mgt. on Damaged Lands	62	87 ha	Not Yet Known		
Variety Trials for Vine Decline	3	Information to be shared with all farmers in region (on more than 500 hectares)	Unknown	NA	
Totals	67	101 ha + >500 ha*	\$100,000	\$100,000	\$200,000

* The first number indicates farms where we provided direct assistance; the second number reflects the lands that will be affected as a result of the vine decline variety trials.

Table 5. Watermelon- Aguan

<i># of Producers in Project: 117 # of Groups in Project: 4</i>					
Type of Rehabilitation Work	Number of Producers	Area Affected/Quantities	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Land Leveling	5	19 ha	\$19,000	\$9,500	\$28,500
Irrigation	112*	15 ha*	\$7,500	\$15,000	\$22,500
Soil Sampling, Fertility Mgt. on Damaged Lands	117	34 ha	Not Known	NA	
Totals	117	34 ha	\$26,500	\$24,500	\$51,000

* These quantities include a large (65 ha) irrigation project (Cayo Sierra) that we repaired. Only 5 ha of this project will be used for watermelon production, but all cooperative families will be involved.

Figure 23. Irrigation assistance for Choluteca and Aguan lower watersheds.



Land reparations to Mitch-damaged vegetable fields in Choluteca and Aguan raised land values by an average of \$1300/hectare. In the case of high value vegetable crops, land was washed away and/or irrigation systems were destroyed. USDA collaborated with the U.S. Army of Corps of Engineers (also funded by USAID) on the design and development of gabion diversion dams and repair of a canal-based irrigation system. USDA also collaborated with Lifewater Foundation, a US-based NGO, in drilling low-cost wells for small irrigation systems.

Table 6. Vegetable Production-Choluteca

<i>Number of Small and Medium Vegetable Producers in Region: > 200</i>					
<i>Number of Producers in Project: >61 Number of Groups in Project 7</i>					
Type of Rehabilitation Work	Number of Producers	Area Affected	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Land Leveling	6	4 ha	\$8,000	\$4,000	\$12,000
Irrigation/Wells/Dams	48	43 ha, 5 wells 2 dams	\$43,000	\$43,000	\$86,000
Technical Assistance	51	17 ha additional*	Not Yet Known	NA	
Soil Sampling/Fertility Mgt. Assistance	61	103 ha	Not Yet Known	NA	
Totals	61	103	\$51,000	\$47,000	\$98,000

*17 hectares over and above the 47 hectares included in land leveling and irrigation

Table 7. Vegetable Production-Aguan

<i>Number of Producers in Project: 145 Number of Groups in Project 6</i>					
Type of Rehabilitation Work	Number of Producers	Area Affected	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Land Leveling	28	7 ha	\$7,000	\$3,500	\$10,500
Irrigation	117	107 ha	\$53,500*	\$107,000	\$160,500
Soil Sampling, Fertility Mgt. Assistance	145	114 ha	Not Yet Known		
Totals	145	114 ha	\$60,500*	\$162,500	\$171,000

* This figure is a projection of increased income; the systems were just being put into use as the project closed.

Cashew farmers in the Choluteca lower watershed received assistance in soil fertility management to help boost production. The cashew sector was only slightly damaged by Mitch but because most of the cashew farmers are also farm laborers in other (damaged) sectors, they were severely impacted. The potential for increasing cashew profits is quite good, but is mainly contingent upon obtaining better credit terms in order to sell on the world market where prices are twice what farmers currently receive. In the meantime, better fertility management has the potential to increase yields by about 20%.

Table 8. Cashew-Choluteca

<i># of Cashew Producers in Region: > 880</i> <i># of Producers in Project: 121 # of Groups in Project: 4</i>					
Type of Rehabilitation Work	Number of Producers	Area Affected	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Soil Sampling/Fertility Mgt	121	265 ha	Not Known	Not Known (if any)	Not Known

Technical assistance in soil fertility management, land leveling, and replanting of plantain benefited 151 farmers, mainly in the Aguan lower watershed.

Since floodwaters destroyed most of the plantain crop, replanting was needed especially in the Aguan watershed which produces a much larger crop than Choluteca. First, USDA identified groups of small growers who had lost their plantings during the hurricane and then organized them to apply for financial assistance for replanting. By June 2001, it became evident that these small growers needed the assistance of a plantain production specialist which USDA provided. Since fertilizers represent one of the highest costs of production and since the soils had changed dramatically as a result of the deposits of sediment, USDA also provided resources for the sampling and analyses of soils and the development of fertility management plans for the producers. (See Tables 9-10 on following page.)

Table 9. Plantain- Choluteca

# of Producers in Project: 3 # of Groups in Project: 2 Total Area of their Farms: >45 ha					
Type of Rehabilitation Work	Number of Producers	Area Affected/Quantities	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Installation of Irrigation	1	7 ha	\$7,000	\$7,000	\$14,000
Soil Sampling/Fertility Mgt	3	17 ha	Not Yet Known		
Technical Assistance	3	17 ha	Not Yet Known*		
Totals	3	17 ha.			\$14,000

* Plantain plantations in the Aguan receiving technical assistance are producing on average about 25% higher, therefore it would be logical to have projected an additional \$250/ha increase in value (\$4,250).

Table 10. Plantain- Aguan

# of Producers in Project: 148 # of Groups in Project: 7 Total Area of their Farms: >240 ha					
Type of Rehabilitation Work	Number of Producers	Area Affected/Quantities	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Land Leveling	6	6 ha	\$3,000	\$3,000	\$6,000
Irrigation	79	35 ha	\$17,500	\$35,000	\$52,500
Replanting	83	107 ha	\$53,500*	\$53,500*	\$107,000
Soil Sampling/Fertility Mgt. Assistance	148	127 ha	Not Known		
Technical Assistance	148	127 ha	Not Known**		
Totals	148	127 ha	\$74,000	\$91,500	\$165,500

*Hurricane Michelle, which occurred in November caused 50% losses of plantings. Expected value of the interventions would have been twice as high.

** Plantain plantations receiving technical assistance are producing on average about 25% higher, therefore it would have been possible to have projected an additional \$250/ha increase in value for the 127 ha (or \$31,750 additional).

Technical assistance to support the rehabilitation of oil palm, citrus, and Tilapia fish-ponds improves over 2000 hectares of Mitch-damaged land. A number of USDA-led interventions benefited a total of 795 oil palm, citrus, or fish producers in the Aguan and Choluteca watersheds.

Table 11. Oil Palm-Aguan

<i># of Producers in Project: 335 # of Groups in Project: 5 Total Area of their Farms: >2,250 ha</i>					
Type of Rehabilitation Work	Number of Producers	Area Affected, Quantities	Value of Intervention (Value of 1st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Replanting	160	170 ha	NA	\$85,000	\$85,000
Soil Sampling/ Fertility Mgt. and Tech. Assistance	335	1585 ha	\$15,850*	NA	\$15,850
Totals	335	1585 ha	\$15,585	\$85,000	\$100,850

* Based on very conservative estimate of cost savings plus increases in yield of about \$10 /ha.

Table 12. Tilapia- Aguan

<i># of Producers in Project: 172 # of Groups in Project: 5 Total Area of their Farms: 571 ha</i>					
Type of Rehabilitation Work	Number of Producers	Area Affected/Quantities	Value of Intervention (Value of 1st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Pond Construction	99	2 ha	\$18,000	\$14,000	\$32,000
Repairing Existing Ponds	60	1 ha	\$9,000	\$5,000	\$14,000
Installing Water Supply Systems	167	200 ha		\$50,000	\$50,000
Stocking Ponds	172	6 ha	\$13,500		\$13,500
Technical Assistance	172	From planning to construction to fish production to marketing	Not Known	NA	
Totals	172	203 ha	\$40,500	\$69,000	\$109,500

Table 13. Citrus-Aguan

<i>Number of Producers in Project: >290 Number of Groups in Project: 5 Total Area of their Farms: Unknown</i>					
Type of Rehabilitation Work	Number of Producers	Area Affected, Quantities	Value of Intervention (Value of 1 st Year Increase in Production)	Increase in Land Value Resulting from Intervention	Total Value of Improvements
Soil Sampling, Fertility Mgt. Tech. Assistance	290	240 ha	\$2,400*	NA	\$2,400
Disease Management Tech. Assistance	290	240 ha	\$2,400*	NA	\$2,400
Totals	290	240 ha	\$4,800		\$4,800

* Based on very conservative estimate of cost savings plus increases in yield of about \$10 /ha.

Key Accomplishments/New Technologies under IR 1.3

Local capacity strengthened to mitigate future storm effects

The rehabilitation work supported by USDA in the Aguan and Choluteca lower watersheds has strengthened farmers' capacity to mitigate future storm effects through the proper repair of their lands and new and/or improved management practices and information. The table below summarizes the types of interventions, amount of land improved, and number of farmers directly affected.

Table 13. Summary by Type of Rehabilitation Intervention

Type of Intervention	Choluteca		Aguan	
	# Farmers	No. of Ha	# Farmers	No. of Ha
Land Leveling	118	211	42	39
Irrigation	139	362	334	198
Replanting	176	342	305	362
New Crops	21	31	361	152
Soil Sampling/Fertility Mgt	423	1839	1035	2100
Variety Trials	525	>5000		
Wells, Dams, Reservoirs	>110	2 dams, 15 wells, 4 reservoirs	340	6 dams, 2 reservoirs
Other Farm Infrastructure	23	NA	29	NA
Feed Preservation	173	NA	13	NA
Land Protection	4	12	72	16
Farm Mgt. Plans	51	457	13	121



Figure 23. Soil sampling in a reclaimed sugar cane field

Other capacity strengthening activities include:

- The training of more than 40 community leaders/facilitators in over 20 communities to help coordinate efforts in their communities to implement group projects such as the construction of community dams for irrigation and/or fish production. These facilitators played critical roles in mitigating the damage from another major hurricane, Michelle, that struck the Aguan in November, 2001.
- The training of more than 30 farmer-leaders to coordinate, push forward, and monitor the processes to rehabilitate farms and improve fellow farmers' capacities in areas such as raising livestock and producing silage. These farmer-leaders have continued to drive the efforts towards productivity improvements with other farmers in their respective groups.
- The spin-off of two private businesses--one affiliated with the largest sugar mill in the Choluteca Valley and dedicated to well-drilling, and the other dedicated to agricultural sales and technical services—which are continuing post-HMRP efforts to increase the productivity and profitability of farm enterprises in Choluteca.
- Innovative technologies generated through the joint efforts of farmers, local technicians, USDA technical specialists and U.S. Army Corps of Engineers staff. These include a low-cost dams, wells and drip irrigation systems, as well as innovations in nutrient management in sugar cane.
- The organization of a multi-sector effort in Choluteca to identify critical research needs and clarify the appropriate role of their local experiment station in responding to those needs. This work has evolved into an organized group established to manage the research station, with an agreement formalized between the group and the Secretariat of Agriculture.

- The analyses of local government experiences in natural resource management designed to aid new mayors and others in civil society in small towns in planning their own endeavors in this arena. The lessons learned are being put to use in numerous municipalities on the North Coast of the country.

Also significant (but not projected here) are the potential gains in income that will accrue to farmers and others in each region as result of the land improvements, the continued use of the new technologies introduced, the gains in yield, and the demonstration value of the rehabilitation interventions themselves.

This last value is especially interesting, and is best described through an example. After Mitch, land values in the sugar-producing region of Choluteca plummeted because much of area was left untillable with mounds of debris and sediment deposited by the floodwaters. After the land was repaired, farmers began to see that not only could they return to producing sugar on that land, but they could actually produce better yields than before because the sediments brought in by the floods actually improved the soil. Now the price for land is higher than it was before Mitch. USDA-introduced rehabilitation technologies (e.g., installing fishponds, producing/conserving better forage, building simple dams for irrigation) continue to inspire farmers to innovate.

Practical Impact of USDA's Assistance

- Through installation of improved drainage structures, and correction of numerous soil erosion and water runoff problems, 163 road exigencies were eliminated and 43.8 kilometers of rural farm-to-market roads in were rehabilitated.
- 100 houses were protected from excessive water runoff and flooding at Colonia La Pista, an emergency community built north of La Libertad for victims of Hurricane Mitch.
- 78 hectares of water sources were protected by fencing in selected areas of the Humuya watersheds, resulting in greater protection of communities' potable water from sediment and contamination.
- Reforestation with 217,175 trees on 621 hectares of critical areas in targeted micro-watersheds of the Humuya helped stabilize slopes, establish trees on degraded lands, and reduce vulnerability to future storms.
- A total of 8 km of streams were rehabilitated by stabilizing damaged stream banks through the use of bio-engineering techniques and vegetative planting.
- Six sites, comprising 10.5 hectares of landslides, were stabilized through vegetative plantings.

- Planting of 56,283 linear meters of live erosion control barriers reduced soil erosion by holding soil in place in sloping agricultural land.
- Sources of microbial contamination to water in the Humuya from human waste were reduced by the building of 524 latrines
- Many sources of sediment in the critical areas of the Humuya upper watershed were removed through the elimination of road exigencies.
- Significant pollution of water from coffee processing was reduced through the use of new technology in coffee de-pulping, with an estimated reduction of 646,800 liters of polluted water from three sub-watersheds.
- Communities are better organized to plan and implement activities to protect water sources, rehabilitate roads, and manage their micro-watersheds.
- Planting of 80,178 linear meters of live-fencing reduced the need to cut wood for fence-posts, helping to maintain tree cover in the watershed.
- Installation of 1,131 improved, fuel-efficient stoves, reduced the need for deforestation for fuel-wood, and increased the opportunity to retain protective tree cover in the watershed.
- Training in water quality monitoring improved local capacity in this technical area, and revealed high fecal coliform counts in potable water systems, highlighting the need for improved watershed management to reduce contamination.
- Fondo Cafetero Nacional and local communities have increased capacity to build and maintain environmentally-sound farm-to-market roads.
- Training of farmers in organic farming, soil conservation, establishment of tree plantations, and agroforestry, along with the training of artisans in the making of improved stoves, has improved local capacity for future work in the Humuya.
- Construction of 202 latrine/kitchen annexes improved homes built for victims of Hurricane Mitch, and reduced household sources of stream water contamination.
- Provision of 3 mobile earthen block machines greatly supports home building to replace destroyed, damaged, or vulnerable houses in the Humuya upper watershed.
- Expert training and consultation in earthen adobe home construction improved sturdiness of new homes, reducing vulnerabilities to severe storms and earthquakes.
- Construction of school/storm shelter at Brisas del Campo improves community infrastructure.

- Improvements in drainage protected 100 houses constructed for hurricane victims from flooding and other water damage.
- Technical assistance in dairy for 254 farmers in the Aguan and Choluteca watersheds had a beneficial impact on 743 ha. of dairy agricultural land, and added \$714,000 in land value.
- Sugar cane lands in Choluteca area damaged by Hurricane Mitch gained \$1000 a hectare or more in value after technical assistance in land leveling and soil mixing.
- Interventions of land leveling, irrigation, and technical advice to rehabilitate Choluteca's important melon growing lands directly helped 67 producers to recover.
- Irrigation and other assistance raised land value of 161 ha. damaged by Mitch by an average of \$1300 per hectare, aiding vegetable farmers in the Choluteca and Aguan lower watersheds.
- Technical assistance in soil fertility management, land leveling, and replanting of plantain benefited 151 farmers, mainly in the Aguan lower watershed.
- Technical assistance to support the rehabilitation of oil palm, citrus, and Tilapia fish-ponds affects over 2000 hectares of Mitch-damaged land.

Additional Measures to Protect the Investment/Recurring Costs

USDA's resources resulted in the establishment of physical works (landslide stabilization structures), the purchase of equipment (coffee processing machines, earthen-block machines, culvert pipes, etc.), the development of technical approaches (bio-engineering on stream banks, improved home construction, construction of small-scale dams for irrigation, etc), and the training of host country NGOs and local communities to manage these various activities into the future. Other than some regular maintenance, no additional measures need to be taken to support the Honduras programs. If additional funding becomes available in the future, it would be useful to do a follow-up review on the impact of the activities.

Other Activities to Consider to Mitigate Future Disasters

Although the area of watershed treated was significant, there still remain many additional areas of vulnerability on steep slopes that could be treated if resources were available.

On the macro level, USAID should continue addressing development in Honduras under a watershed approach, integrating agricultural, environment, and rural development concerns.

Budget for the Honduras HMRP: US\$ 2,497,907